

Feeding and Associated Morphology in *Sanguinolaria nuttallii*

(Bivalvia : Tellinacea)

BY

ROSS H. POHLO

Department of Biology, San Fernando Valley State College, Northridge, California 91324

(3 Text figures)

INTRODUCTION

Sanguinolaria nuttallii Conrad, 1837 is a large tellinacean that inhabits sandy areas in bays and ranges from Bodega Bay, California to Magdalena Bay, Baja California (McLEAN, 1969). Until recently all of the Tellinacea were regarded as deposit feeders (YONGE, 1949, 1952; MORTON, 1960; and JØRGENSEN, 1966), but several authors (HOLME, 1961; BRAEFIELD & NEWELL, 1961; PURCHON, 1963; WADE, 1965; POHLO, 1966, 1967, 1969; MAURER, 1967; and REID & REID, 1969) have demonstrated that both suspension and deposit feeding and a combination of the two types of feeding occur within the group. The purpose of this paper is to examine the feeding behavior of *S. nuttallii* and to determine if any features of morphology are associated with feeding type. To this end the behavior and morphology of *S. nuttallii* are compared with a typical deposit feeder and a suspension feeding tellinacean.

MATERIALS AND METHODS

This organism was obtained from Mugu Lagoon and Newport Bay, California where the species occurs in great abundance. It occurs intertidally in clean sand, although McLEAN (1969) reports it also occurs in gravel, and lives in the substratum at a depth of about 15 - 25 cm.

Several methods of study were used to ascertain the feeding behavior of this form. Direct underwater observations of siphons were made using an underwater viewer in shallow water. Observations of this nature were also made in aquaria in the laboratory.

Movement of particles in the mantle cavity was observed by removing the left valve with its mantle lobe and placing fine carborundum or carmine suspension on various portions of the anatomy.

To study the diet of these organisms, the animals were unearched in the field, the mantle cavity was opened, and

the soft parts were then immediately preserved in 70% alcohol solution. The alimentary canal was later dissected out and the anatomy of the stomach, and its contents, were then observed. When using live specimens, the stomach was entered from the dorsal side and the ciliary patterns were studied by placing carborundum or carmine particles in various areas.

FUNCTIONAL MORPHOLOGY

Shell: As shown in Figure 1, the shell of *Sanguinolaria nuttallii* is slightly elongated. The large specimens are

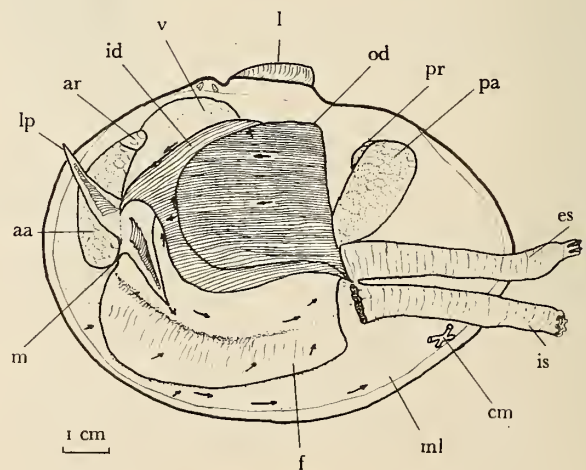


Figure 1

Mantle cavity of *Sanguinolaria nuttallii* Conrad, 1837 viewed from the left side. Left valve and mantle lobe removed. Arrows indicate the direction of particle movement.

aa - anterior adductor	ar - anterior retractor
cm - cruciform muscle	es - exhalant siphon
id - inner demibranch	is - inhalant siphon
lp - labial palp	m - mouth
od - outer demibranch	ml - mantle lobe
pr - posterior retractor	pa - posterior adductor
	v - visceral mass
	f - foot
	l - ligament

about 10 cm long and 7 cm high. The shell is covered with a glossy brown periostracum that gives the organism its characteristic varnished appearance. The ligament is external and quite large. On a large specimen it is about 2.5 cm long, 1.5 cm wide and 0.5 cm high, substantially larger than in most other Tellinacea.

Mantle Cavity: The organs of the mantle cavity are shown in Figure 1. It is seen that the demibranchs (OD and ID) are quite large and the labial palps (LP) small. In several of the Tellinacea the outer demibranch is up-turned, as in *Macoma* and *Tellina*, but this is not the case in this species. A mantle fold, also present on the anterior margin of the inhalant siphon in some other Tellinacea, is lacking. A cruciform muscle is present as it is in most of the other Tellinacea.

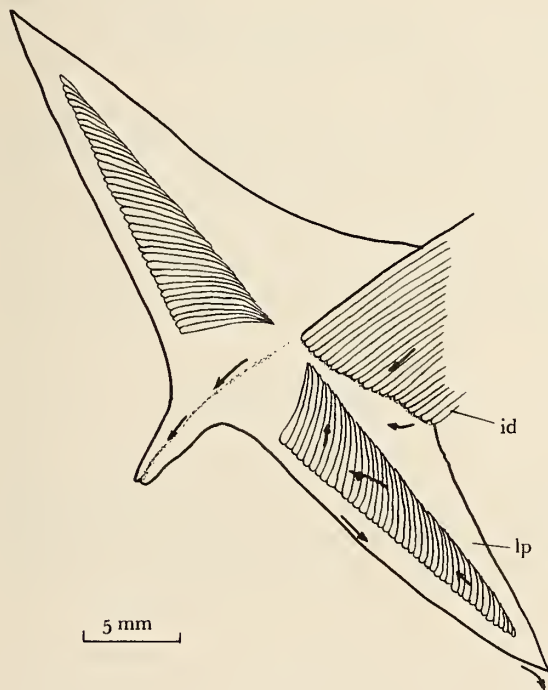


Figure 2

Feeding currents on the labial palps

id - inner demibranch

lp - labial palps

The ciliary feeding and rejection currents are shown in Figures 1 and 2. The anatomical relationship of the ctenidia and labial palps is of category III (*i. e.*, the anterior filaments of the inner demibranch are not inserted into the distal oral groove, see STASEK, 1963). Particles gener-

ally move antero-ventrally on the outer demibranch to the inner except near the dorsal margin of the outer demibranch where they may move in a dorsal direction. Material usually moves directly from the outer demibranch to the inner but some material can be carried by weak currents along the ventral portion of the outer demibranch. Once material moves onto the inner demibranch it moves toward the antero-ventral edge and is then carried by a rather strong dorsalward current towards the labial palps. On neither demibranch is a food groove present.

Once particles have reached the labial palps they are moved toward the posterior margin of the palp plications and then dorsally toward the mouth (Figure 2). If material has reached the palp plications it can move perpendicular to the plications and then also toward the mouth. Substances to be rejected move to the anterior margin and then are carried ventrally toward the foot.

Siphons: The morphology of the siphons is shown in Figure 1. Both the inhalant and exhalant siphons are ringed with 6 lobes. The lobes on the exhalant siphon are rather long and finger-like, those on the inhalant siphon are short and rather blunt. There are no straining tentacles present, such as those seen on the majority of eulamelli-branches. The siphons are quite sensitive and are rapidly retracted when the organism is disturbed.

Stomach: The stomach (Figure 3) is characterized by the major typhlosole (T) and its corresponding intestinal groove (IG) entering both the right and left caeca (RC, LC). This is characteristic of stomach type V (PURCHON, 1960). In *Sanguinolaria nuttallii* the typhlosole and intestinal groove pass antero-dorsally from the mid-gut (MG) into the stomach and enter the right caecum. They make a short "U"-shaped loop in this structure and leave from the left side. They then enter the left caecum on the dorsal side, go deeply into it, move to the ventral portion and back toward the mouth of this caecum, where they terminate in a curl.

The style sac (SS) and mid-gut are conjoined. There is a minor typhlosole (t) that emanates from the mid-gut and terminates on the postero-ventral floor of the stomach.

The dorsal hood (H) is large and receives a curved portion of the gastric shield. Particles move out of the dorsal hood via the rejection groove (RG), enter the intestinal groove and then move into the mid-gut. The left pouch (LP) is large and has a sorting area on its ventral side. There is a large, elongated appendix (X) that emanates on the right posterior side of the stomach wall; it runs postero-ventrally and terminates blindly.

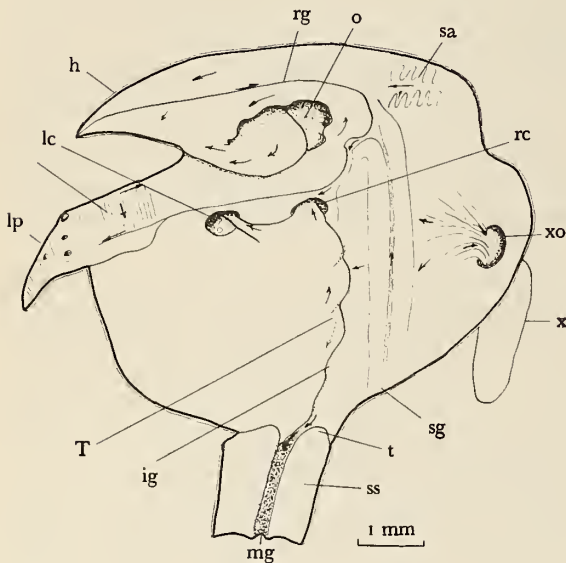


Figure 3

Stomach of *Sanguinolaria nuttallii* Conrad, 1837 opened from the left side. Gastric shield removed. Arrows indicate direction of particle movement.

h - dorsal hood ig - intestinal groove lc - left caecum
 lp - left pouch mg - mid gut o - opening of oesophagus
 rc - right caecum rg - rejection groove sa - sorting area
 sg - sorting groove ss - style sac T - major typhlosole
 t - minor typhlosole x - appendix
 xo - opening of appendix

FEEDING OBSERVATIONS

Sanguinolaria nuttallii was observed *in situ* in Mugu Lagoon. Observations were made when the organisms were covered with about 10 to 30 cm of water. Animals were also kept in an aquarium and the feeding behavior was noted.

In the field the siphons were never observed above the level of the substratum. Most of the time the inhalant siphon appeared about 0.5 to 1 cm below the level of the substratum in what appeared to be a semipermanent siphonal burrow. The siphons are inactive, in contrast to the siphons of animals such as *Donax gouldii* Dall, 1921, *Tagelus californianus* (Conrad, 1837), and *Macoma nasuta* (Conrad, 1837), where they are quite active. The inhalant siphon was never observed actively ingesting deposits as seen in *Macoma nasuta* (MACGINITIE, 1935) or

Macoma secta (REID & REID, 1969). The same general type of feeding pattern was noted in the aquarium except that, occasionally, the inhalant siphon was observed above the level of the substratum, but it was never seen actively ingesting deposits. The organisms that extended their siphons above the substratum appeared moribund, and this behavior was never seen in the field.

The mantle cavities of numerous specimens were opened in the field. Some organisms showed little or no sand grains in the mantle cavity, while others contained a considerable amount. Usually, most of the sand was on the foot or in the area of the pseudofeces accumulation, just ventral to the inhalant siphon. These clams were immediately preserved and later the contents of the digestive tract were observed. As with the contents of the mantle cavity, some organisms had no sand grains in the stomach while in others some sand was present. Diatoms, flagellates, and amorphous green debris were always present in the stomach and appear to be the main sources of nourishment.

From the above mentioned information it is apparent that *Sanguinolaria nuttallii* feeds primarily on suspended material. But, because the siphons have no effective straining tentacles and the siphons are below the level of the substratum, deposits can and do fall into the inhalant opening and, if small enough, these particles can reach the stomach. But the main source of food is still suspended material.

DISCUSSION

I classify *Sanguinolaria nuttallii* as a non-selective suspension feeder. It is of interest to compare its behavior and morphology with those Tellinacea that are clearly deposit feeders, *e. g.* *Macoma secta* (Conrad, 1837) or *M. nasuta* and those that are suspension feeders, *e. g.* *Donax gouldii*.

The majority of the Tellinacea that are deposit feeders share the following characteristics: the labial palps are large, the demibranchs relative to the size of the palps are small, the outer demibranch is upturned, a mantle fold is present, there is an absence of straining tentacles on the inhalant siphon, a food groove on the inner demibranch is absent. Also these organisms lie on their side.

Donax gouldii, a suspension feeding tellinacean that actively rejects deposits (POHLO, 1967), has the following characteristics: the labial palps are small, the demibranchs large, the outer demibranch is not upturned, a mantle fold is absent, straining tentacles are present on the inhalant siphon, a food groove is present on the inner demibranch, and the organism is upright in the burrow.

Comparing *Sanguinolaria nuttallii* with the 2 types of feeders mentioned above, the following is noted: the labial palps are small, the demibranchs are large, the outer demibranch is not upturned, and a mantle fold is absent. All of these features are characteristic of suspension feeding. The features that *S. nuttallii* shares with the deposit feeding Tellinacea are: absence of straining tentacles on the inhalant siphon, absence of a food groove, and its position in the burrow, *i. e.*, lying on its side.

These morphological and behavioral associations and the type of feeding in this form indicate that *Sanguinolaria nuttallii* is somewhere in between the deposit and purely suspension feeders. On the basis of its feeding and morphology it seems to be more closely allied with suspension feeders.

ACKNOWLEDGMENT

I wish to thank Dr. Marvin Cantor for reading the paper.

Literature Cited

- BRAEFIELD, A. W. & G. E. NEWELL
1961. The behavior of *Macoma balthica* (L.) Journ. Mar. Biol. Assoc. U. K. 41: 81 - 87
- HOLME, NORMAN A.
1961. Notes on the mode of life of the Tellinidae (Lamellibranchia). Journ. Mar. Biol. Assoc. U. K. 41: 699 - 703.
- JØRGENSEN, G. BARKER
1966. Biology of suspension feeding. Pergamon Press, New York
- MACGINITIE, GEORGE EBER
1935. Ecological aspects of a California marine estuary. Amer. Midl. Natur., 16 (5): 629 - 765; 21 text figs. (September 1935)
- MAURER, DON
1967. Mode of feeding and diet, and synthesis of studies on marine pelecypods from Tomales Bay, California. The Veliger 10 (1): 72 - 76 (1 July 1967)
- MCLEAN, JAMES HAMILTON
1969. Marine shells of southern California. Sci. Ser. 24, Zool. no. 11; 104 pp., 54 text figs.
- MORTON, JOHN EDWARD
1960. Molluscs: An introduction to their form and functions. New York, Harper Bros. 232 pp.; 23 text figs.
- POHLO, ROSS H.
1966. A note on the feeding behavior in *Tagelus californianus* (Bivalvia: Tellinacea). The Veliger 8 (4): 225; 1 text fig. (1 April 1966)
1967. Aspects of the biology of *Donax gouldi* and a note on the evolution in Tellinacea (Bivalvia). The Veliger 9 (3): 330 - 337; 5 text figs. (1 January 1967)
1969. Confusion concerning deposit feeding in the Tellinacea. Proc. malacol. Soc. London 38: 361 - 364
- PURCHON, RICHARD DENISON
1960. The stomach in the Eulamellibranchia; Stomach Types IV and V. Proc. Zool. Soc. London 135 (3): 431 - 489; 19 text figs. (20 October 1960)
1963. A note on the biology of *Egeria radiata* Lam. (Bivalvia, Donacidae). Proc. malacol. Soc. London 35: 251 - 271
- REID, ROBERT GEORGE BURNSIDE & ALISON REID
1969. Feeding processes of members of the genus *Macoma* (Mollusca: Bivalvia). Canad. Journ. Zool. 47: 649 - 657
- STASEK, CHARLES ROBERT
1963. Synopsis and discussion of the association of ctenidia and labial palps in the bivalved Mollusca. The Veliger 6 (2): 91 - 97; 5 text figs. (1 October 1963)
- WADE, BARRY A.
1964. Notes on the ecology of *Donax denticulatus* (LINNÉ). Proc. Gulf and Caribb. Fish. Inst. 17th Annual Session: 36 - 41
- YONGE, CHARLES MAURICE
1949. On the structure and adaptations of the Tellinacea, deposit-feeding Eulamellibranchia. Phil. Trans. Roy. Soc. London (B) 234 (609): 29 - 76; 29 text figs. (5 Sept. 1949)
1952. Studies on Pacific coast mollusks. IV. Observation on *Siliqua patula* DIXON and on the evolution within the Solenidae. Univ. Calif. Publ. Zool. 55: 421 - 438.

